COPY 2

Acacia farnesiana (L.) Willd. Aroma, huisache

Leguminosae (Mimosoideae) Legume family

SO-ITF-SM-49
March 1992

UNIVERSITY OF MINNESOTA
MAR 18 1993
FORESTRY LIBRARY

John A. Parrotta

Acacia farnesiana (L.) Willd., commonly known as aroma or huisache, is a multistemmed, deciduous shrub or small tree characterized by a dense, spreading crown, spiny branches, and fragrant flowers. Aroma is probably native only along the Mediterranean coast, although it is naturalized in many parts of the New and Old World tropics and subtropics where it has been introduced. It is a useful species for reforestation of degraded drylands; it is also used extensively for fuel and small timber and in the perfume industry in southern France. In some locales, it is considered a pest due to its ability to colonize pastures and other disturbed habitats (fig. 1).

HABITAT

Native Range

Aroma is considered native only to southern France, Italy, and elsewhere along the northern Mediterranean coast. It was introduced to the New World during the early years of Spanish colonization. The type botanical specimen described by Linnaeus was collected in the Dominican Republic. Following its introduction, aroma has been spread by livestock and disturbances associated with grazing such as fire, brush cutting, and browsing. It has become naturalized throughout the West Indies; in the Southern United States, from California to Florida; Mexico, Central America; South America as far south as Chile and Argentina; and in many parts of the Old World tropics and subtropics, including India *(22, 27)*, North Africa *(10)*, and Nigeria *(14)*. It is present on all continents (between 30° N. and 40° S. latitudes) and is the most widely distributed species of *Acacia (43)*.

Climate

Aroma generally requires a mean annual rainfall of between 500 to 750 mm for good growth, although it can survive in areas receiving as little as 400 mm of annual rainfall, with a dry season lasting from 4 to 6 months *(2, 52)*. In Mexico, aroma grows in areas receiving up to 900 mm of rainfall *(34)*. The species is drought hardy, fire resistant, and susceptible to frost *(52)*. Aroma grows well where mean annual temperatures range from 15 to 28 °C, with mean temperatures of 25 to 32 °C during the hottest months and mean temperatures of 2 to 10 °C during the coldest months *(52)*. However, where it has been naturalized in India, mean maximum temperatures range from 30 to 40 °C during the hottest months and mean minimum temperatures from 4 to 24 °C during the coldest months *(22)*.

Soils and Topography

In Mexico, aroma grows on a wide variety of soils, from heavy clays to sands *(34)*, although best growth occurs in well-drained soils. In areas of India where aroma has become naturalized, the tree grows on sandy alluvial soils and is cultivated throughout the Indo-Gangetic plain on a variety of alluvial soil types. It grows well on nutrient-poor sands in dry forests and is considered useful for soil stabilization in degraded drylands *(12, 22)*. Aroma is not exacting as to soil pH and tolerates saline soils *(52)*.

The tree grows in natural stands at altitudes from sea level to approximately 2,000 m in Mexico *(34)*, and to an elevation of approximately 1,000 m in Central America *(19)*.

Associated Forest Cover

In the xeric shrublands and forests of the Gulf Coastal Plain in northeastern Mexico, aroma is associated with *Acacia berlandieri* Benth., *A. rigidula* Benth., *A. wrightii* Benth., *Helietta parviflora* (A. Gray) Benth., *Leucaena leucocephala* (Lam.) de Wit, *Pithecellobium flexicaule* (Benth.) Coulter, *P. pallens* (Benth.) Standl., *Prosopis juliflora* (Sw.) DC., and *P. laevigata* (H. & B. ex Willd.) M. C. Johnst. *(12)*. In western Mexico, aroma is associated with *A.*

Figure 1.—*Aroma* (Acacia farnesiana) *trees growing in pastures in southwestern Puerto Rico.*

John A. Parrotta is a research forester at the Institute of Tropical Forestry, U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, Río Piedras, PR 00928, in cooperation with the University of Puerto Rico, Río Piedras, PR.

pennulata (Schlecht. & Cham.) Benth. in degraded deciduous forest areas; in the State of Morelos, it is associated with *A. bilimekii* Macbride, *A. cochliacantha* Humb. & Bonpl., *Cassia pringlei* Rose, and *Willardia parviflora* Rose in secondary thickets *(38)*. In subtropical dry forests *(18)* at altitudes up to 2,000 m in Jalísco and Aguascalientes, aroma grows in association with *A. pennulata, Bursera bipinnata* (DC.) Engl., *Eysenhardtia polystachya* (Ortega) Sarg., *Heliocarpus terebinthaceus* (DC.) Hochr., *Hyptis albida* H. B. K., *Ipomea intrapilosa* Rose, *I. murucoides* Roem. & Schult, *Mimosa monancistra* Benth., *Opuntia fuliginosa* Griffiths, and *Tecoma stans* (L.) H. B. K. *(38)*.

Elsewhere in Mexico, aroma forms dense successional stands in southwest Puebla on sites with deep, well-drained soils. On these sites, aroma is eventually replaced by *Prosopis* and *Pithecellobium.* Aroma is also common in secondary forests derived from subtropical thorn forests *(18)* in southeast San Luis Potosí, where it grows with *A. amentacea* DC., *Caesalpinia mexicana* Gray, *Cordia alba* (Jacq.) Roem. & Schult., *Diphysa minutifolia* Rose, *Harpalyce arborescens* A. Gray, *Pithecellobium calostachys* Standl., *Sapindus saponaria* L., and *Thevetia peruviana* (Pers.) K. Schum. *(38)*. In tropical deciduous forests and thorn woodlands *(18)* of the Isthmus of Tehuantepec, aroma is commonly associated with *A. cornigera* (L.) Willd., *A. pringlei* Rose, *A. cymbispina* Sprague & Riley, *Amphipterygium adstringens* (Schlecht.) Schiede, *Bauhinia albiflora* Britt. & Rose, *B. pauletia* Pers., *Caesalpinia coriaria* (Jacq.) Willd., *C. eriostachys* Benth., *Casearia nitida* Jacq., *Cordia curassavica* (Jacq.) Roem. & Schult., *Croton guatemalensis* Lotsy, *D. floribunda* Peyr., *Haematoxylum brasiletto* Karst., *Jacquinia aurantiaca* Ait., *Pereskia conzattii* Britt. & Rose, *Piptadenia flava* Benth., *Pithecellobium dulce* (Roxb.) Benth. *(33)*, *P. tortum* Mart., *Prosopis laevigata*, and *Randia aculeata* L. *(5, 38)*. It is a minor component in forests dominated by *P. laevigata* at altitudes ranging from 1,000 to 2,000 m in many parts of Mexico, including much of the area west of the Isthmus of Tehuantepec *(38)*.

In Puerto Rico, aroma has become naturalized in thickets and forests in many dry coastal and dry limestone regions *(27)* and commonly grows in association with *Pithecellobium dulce (33)* and *Prosopis pallida* (H. & B. ex Willd.) H. B. K. In Barbados, aroma grows in xerophytic shrub formations on rocky hillsides with *Leucaena leucocephala* (Lam.) de Wit, *Pisonia aculeata* L., *Psidium guajava* L., *Tecoma stans* (L.) H. B. K., and *Ziziphus mauritiana* Lam. *(15)*.

In India, where aroma has been cultivated and naturalized throughout much of the drier regions of the country, it occurs most commonly in dry deciduous forests, particularly in sandy river beds, in pure stands or in association with *Dalbergia sissoo* Roxb. *(32)* and *Tamarix dioica* Roxb. *(22)*.

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—Aroma is known to flower as early as the second year following germination, with pods produced as early as the third year *(22)*. Flowering season varies with local climate; trees are recorded in flower from November to February in Puerto Rico *(27)*, from December to March in Central America *(19)*, from January to April in northwestern India, and from September to February in eastern India *(22)*. Numerous yellow flowers form fragrant, globose heads, which are borne one to three together on hairy stalks 1.8 to 3.6 cm long *(27)* (fig. 2). Individual flowers consist of a tubular five-toothed calyx (3 mm long), a tubular five-toothed corolla (6 mm long), many threadlike stamens 6 mm long, and a pistil (4.8 mm long) with a narrow ovary and slender style *(27)*.

The fruits, generally produced in abundance from the time the tree is about 3 years old, are thick, slightly flattened pods, dark brown to blackish in color when ripe, 3.6 to 7.6 cm long, and 3 to 12 mm wide. The fruits form rapidly after flowering, reaching full size in 2 to 4 months and ripening approximately 2 months later. A sample of pods collected in Puerto Rico contained between 11 and 23, averaging 14.4 ± 1.2, seeds per pod (author, personal observation).

Seed Production and Dissemination.—Aroma seeds are small, elliptical, and slightly flattened, 8 mm long, and brown in color with a hard seedcoat *(27)*. While the literature indicates that there are approximately 11,000 to 13,000 seeds per kilogram *(22, 52)*, two samples of 100 air-dry seeds from Puerto Rico averaged 0.132 ± 0.004 g and 0.130 ± 0.006 g per seed, respectively, or about 7,600 seeds per kilogram (author, personal observation).[1] While livestock are probably the primary means of dispersal in pastures, smaller seed-eating vertebrates such as lizards have been reported to disperse aroma seeds up to 500 m from parent trees in Central American deciduous forests *(48)*. Unless first consumed by livestock, the ripe pods remain attached to the tree for several months and generally fall to the ground without dehiscing. Seeds are released from pods following decay or insect damage *(22)*. Ripened pods may be collected from branches, air-dried, and crushed to release seeds *(22)*.

Seedling Development.—Germination in aroma is epigeous. Seeds may be sown without pretreatment, although soaking in cold water for 48 hours *(22)* or in hot water for 10 to 20 minutes *(23)* is reported to greatly improve germination. Incubation of seeds at temperatures between 60 and 70 °C for a period of 6 to 12 hours has been found to greatly increase germination percentages *(14)*. Scarification in concentrated sulfuric acid for 20 to 60 minutes or in concentrated nitric acid reportedly resulted in 65 to 70 percent germination *(14, 39)*. Mechanical scarification with sandpaper appears to be the best pretreatment technique, resulting in germination as high as 98 percent *(14)*. Whether mechanical scarification is carried out before or after storage seems to make no difference in germination rates *(24)*.

Mechanically scarified seeds placed on moist filter paper in a petri dish begin germinating within 6 days, with 57-percent germination after 13 days.[1] Seed germination is commonly between 10 and 40 percent for fresh, untreated seeds *(14, 28)*. Seeds remain viable for 30 years or more when

[1]Francis, John K. 1991. Personal communication. Located at U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, Río Piedras, PR 00928.

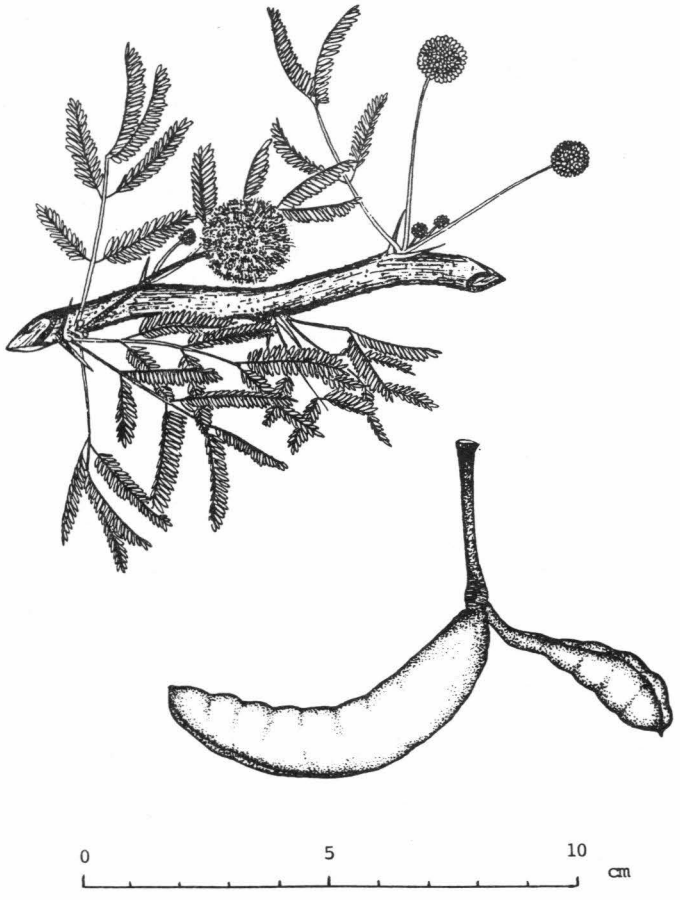

Figure 2.—*Foliage and fruit of aroma* (Acacia farnesiana) *(26).*

stored under dry conditions at ambient temperature *(22)*. In the nursery, the optimal sowing depth is between 2 and 4 cm *(14)*. Aroma seedlings tend to produce a deep taproot in well-drained soils *(15)*.

Natural regeneration of aroma is abundant in natural stands. The seeds often germinate within the fallen pod, resulting in a dense clump of seedlings *(49)*. Germination takes place during the rainy season, but many seeds remain dormant for a full year before germinating *(49)*. Due to its prolific seed production, palatability to livestock, and rapid germination on disturbed soils, aroma can rapidly colonize pastures, often forming dense stands *(35)*.

Plantations may be established by direct seeding or with containerized seedlings or bare-rooted plants *(22)*. Broadcast sowing of scarified seeds in pastures in Texas reportedly resulted in 1 to 2 percent of the seeds sown becoming established seedlings *(30)*. Growth during the first year can be rapid under controlled nursery conditions; in tests conducted in India, maximum seedling heights 1 year after sowing were 63 to 210 cm in rain-fed and irrigated nursery beds, respectively *(49)*. Under field conditions on semiarid sites, seedling heights after 1 year are typically 30 to 50 cm *(12)*.

Vegetative Reproduction.—Aroma reportedly can be propagated vegetatively by cuttings *(52)*. Although no data are available on vegetative reproduction under field conditions, the persistence of aroma in heavily grazed, mechanically cut, and herbicide-treated pastures suggests that the species coppices well.

Sapling and Pole Stage to Maturity

Growth and Yield.—Mature trees are characterized by multiple stems; dark-brown, smooth bark; a branchy, spreading crown of slightly zigzag twigs bearing paired, whitish spines; and light-green foliage. Leaves are bipinnately compound, 5 to 10 cm long, with 2 to 6 pairs of pinnae, each with 10 to 25 pairs of narrow, stalkless leaflets 3 to 9 mm long *(27)*. Heights at maturity generally range from 3 to 5 m (occasionally to 10 m), depending on locality *(19, 22)*. Maximum stem d.b.h. is approximately 45 cm *(46)*.

In 3-year-old plantations established at a 2- by 2-m spacing on a site in Mexico with alkaline, vertisol-like soils, and mean annual rainfall of 750 mm, average basal diameter and tree height were 3.9 cm and 1.5 m, respectively *(12)*. Average height and d.b.h. were recorded as 2.8 m and 4.3 cm, respectively, in 3-year-old plantations established with a 2- by 2-m spacing at a site in Tamil Nadu, India, that received an average annual rainfall of 830 mm *(45)*. An average tree height of 1.5 m was recorded in 4-year-old, direct-seeded plantations at a site in Punjab that received an average annual rainfall of 760 mm *(22)*.

Rooting Habit.—The morphology of the root systems of aroma is variable and may be dominated either by deep taproots or wide-ranging lateral roots, depending on the depth to the water table *(15)*. Like other members of the genus *Acacia*, aroma commonly forms a symbiotic association with bacteria of the Rhizobiaceae, thus enabling it to fix atmospheric nitrogen *(4, 19)*. Association with the mycorrhizal fungus *Endogone calospora* has been reported to improve seedling growth *(21)*.

Reaction to Competition.—Aroma is intolerant of shade and requires free growing space in nurseries and plantations; otherwise smaller seedlings are quickly suppressed by more vigorous individuals *(22)*. It has been successfully interplanted for nitrogen fixation at 1- by 1-m spacings on infertile semiarid sites with *Pinus brutia* Ten. in Iraq *(16)*. Aroma is an aggressive competitor in pastures and other disturbed sites.

Damaging Agents.—Aroma is susceptible to attack by the twig girdler *Oncideres pustulatus* LeConte (Coleoptera: Cerambycidae) in southern Texas *(11, 36)*. In Puerto Rico, aroma seeds and pods are susceptible to attack by bruchid beetles (author, personal observation). Elsewhere, attack by *Mimosestes nubigens* has been reported in Costa Rica *(47)* and attack by the tamarind bruchid beetle *(Caryedon gonagra* Fabricius) in India *(31)*. The green pods are reportedly attacked by the pomegranate butterfly *Virachola livia* Klug (Lepidoptera-Rhopalocera: Cycaenidae) in Egypt *(1)*.

Several leaf and stem pathogens have been reported to infect aroma. *Corticium salmonicolor* Berk. & Br., the cause of "pink disease," has been reported in Sierra Leone *(13)*. Fungal pathogens include *Ravenelia australis* Dict. & Neger, *R. hieronymi* Speg., and *R. siliquae* Long in Texas *(50)*; *R. spegazziniana* Lindquist in Hawaii, the continental United States, Mexico, Guatemala, Cuba, and Puerto Rico; *R. acaciae-farnesianae* P. Henn. in Brazil; *R. formosana* Syd. in

Taiwan; unidentified *Ravenelia* species in Myanmar, New Caledonia, Zambia, and Ethiopia; and *Uromycladium notabile* (Ludw.) McAlp in New Zealand and Australia *(13)*. Other leaf pathogens of minor importance include *Phyllachora acaciae* P. Henn. in the West Indies and Ecuador *(44)* and *Camptomeris albizziae* (Petch) Mason in Dominica, Sudan, Kenya, and South Africa *(13)*. Root diseases affecting aroma include root rot caused by *Clitocybe tabescens* Scop. ex Bres., reported in Florida, and *Phymatotrichum omnivorum* (Shear) Dug., reported in Texas *(50)*. Aroma is the host of the root-knot nematode *Meloidogyne javanica* (Treub) Chitwood in India *(17)*. A serious wilt caused by a species of *Dothiorella* has been noted in Italy *(13)*.

SPECIAL USES

Aroma is considered a useful species for windbreaks, reforestation in degraded dry forest and pasture areas, and for stabilization of shifting sands in degraded semiarid regions *(22, 29)*. In India, aroma is cultivated and pruned as a garden shrub and as a host for lac insects *(22)*.

The sapwood is white to yellowish *(22, 27)*, the heartwood red to reddish brown. The wood is hard, close-grained, and durable, with a specific gravity of 0.79 to 0.84 g/cm^3 *(22, 46)*, and is useful for posts, turnery, cabinet work, agricultural implements, and, particularly, fuel *(7, 51)*. Air-dry wood has a calorific value of 4.6 kcal/g *(52)*.

The perfume obtained from the blossoms, known as cassie, is highly valued *(25)* and has led to the cultivation of aroma in southern France and elsewhere in the Mediterranean *(7, 9, 46)*. In tropical America, the dried flowers are placed between linens and in clothes cabinets as a freshener *(46, 51)*.

The pods and bark are rich in tannins *(43)* and are used in tanning, although not presently on an industrial scale *(46)*. The tree produces a high-quality gum closely resembling, and in some ways superior to, gum arabic obtained from *Acacia nilotica* (L.) Delile *(22, 27, 46)*. A black dye, used for ink and dyeing leather, is produced from the pods *(46, 51)*. The thick juice of the pods is useful as a mucilage *(46)*. The leaves are reported to contain cyanogenic compounds *(41, 42)*.

In Mexico, aroma has many traditional medicinal uses *(46)*. Extracts from the flowers are used in headache remedies and in the treatment of indigestion. The green fruit is very astringent and a decoction from the fruit is used to treat dysentery and skin inflammations. In San Luis Potosí, a decoction of the roots is employed as a supposed remedy for tuberculosis. The pulverized, dried leaves are sometimes applied as a dressing for wounds.

In West Africa, the roots are sometimes chewed for sore throats, and the astringent bark and leaves are used in lotion for sores and skin diseases and in a potion for diarrhea *(20)*. Among the Bhils, a tribal group in Rajasthan (India), the dried inflorescence is powdered and taken internally as a treatment for venereal disease *(40)*.

Aroma is a seasonally important source of pollen for honey production in Cuba *(8)*. Throughout its range, aroma leaves and pods serve as livestock fodder.

GENETICS

Among the mimosoid legumes, few species exhibit the systematic complexity of *A. farnesiana*, which is considered an assemblage of species or microspecies. Closely related species segregated from the *A. farnesiana* complex include *A. smallii*, distributed in the Southern United States and northern Mexico; *A. pinetorum* in southern Florida; and *A. caven*, an extratropical South American taxon *(6, 42)*. Botanical synonyms include *A. cavenia* Bert. *(50)*, *A. leptophylla* DC. *(3)*, *Vachellia farnesiana* (L.) Wight &. Arn., and *Mimosa farnesiana (26, 37)*. *Acacia farnesiana* is a tetraploid species (2n = 52) *(42)*.

LITERATURE CITED

1. Awadallah, A.M.; Azab, A.K.; El-Nahal, A.K.M. 1971. Studies on the pomegranate butterfly, *Virachola livia* (Klug) (Lepidoptera-Rhopalocera: Lycaenidae). Bulletin de la Société Entomologique d'Egypte. 54: 545–567.
2. Badi, K.H. 1967. Afforestation on the clay plains of Kassala Province [Sudan]: (A) High rainfall clay plains. (B) Arid clay plains. Bulletin No. 13. Khartoum: Forest Department 20 p.
3. Bailey, L.H. 1941. The standard cyclopedia of horticulture. New York: MacMillan & Company. 1,200 p. Vol. 1.
4. Balasundaram, V.R. 1987. Studies on the native nodulation and biomass production of some legume trees. Indian Journal of Forestry. 10(2): 94–96.
5. Breedlove, D.E. 1973. The phytogeography and vegetation of Chiapas (Mexico). In: Graham, A., ed. Vegetation and vegetational history of northern Latin America. Amsterdam: Elsevier Scientific Publishing Co.: 149–165.
6. Clarke, H.D.; Seigler, D.S.; Ebinger, J.E. 1989. *Acacia farnesiana* (Fabaceae: Mimosoideae) and related species from Mexico, the Southwestern U.S., and the Caribbean. Systematic Botany. 14(4): 549–564.
7. Cook, O.F.; Collins, G.N. 1903. Economic plants of Puerto Rico. Contributions from the United States National Herbarium. Part 2. Washington, DC: Smithsonian Institution. 269 p. Vol. 8.
8. Diaz Millan, E.; Moncada, M. 1988. Espectro de la flora folinifera de la localidad de El Cano en la provincia Ciudad de La Habana [Variety of local pollen sources in El Cano, Havana City]. Ciencia y Técnica en la Agricultura, Apicultura. 4(2): 9–43.
9. El-Gamassy, A.M.; Rofaeel, I.S. 1975. The effect of tree age and time of day for collecting the flowers on the flower yield, content and composition of cassie *(Acacia farnesiana)* essential oils. Egyptian Journal of Horticulture. 2(1): 39–52.
10. El-Lakany, M.H. 1987. Use of Australian acacias in north Africa. ACIAR Proceedings. Canberra, Australia: Australian Centre for International Agricultural Research. 16: 116–117.
11. Felker, P.; Reyes, I.; Smith, D. 1983. Twig girdler *(Ondideres* spp.) damage to *Acacia, Albizia, Leucaena,* and *Prosopis* in the New World. Nitrogen Fixing Tree Research Reports. 1: 44–45.

12. Foroughbakhch, R.; Penaloza, R.; Stienen, H. 1987. Increasing productivity in the matorral of northeastern Mexico: domestication of ten native multipurpose tree species. In: Strategies for classification and management of native vegetation for food production in arid zones. Gen. Tech. Rep. RM-150. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 90–98.
13. Gibson, I.A.S. 1975. Diseases of forest trees widely planted as exotics in the Tropics and southern hemisphere. I. Important members of the Myrtaceae, Leguminosae, Verbenaceae and Meliaceae. Oxford, England: Commonwealth Mycological Institute, Unit of Tropical Silviculture, Department of Forestry, University of Oxford. xii + 51 p.
14. Gill, L.S.; Jagede, R.O.; Husaini, S.W.H. 1986. Studies on the seed germination of *Acacia farnesiana* (L.) Willd. Journal of Tree Sciences. 5(2): 92–97.
15. Gooding, E.G.B. 1974. The plant communities of Barbados. Bridgetown, Barbados: Government Printing Office. 243 p.
16. Hasan, S.M.; Al-Saraf, M.J.; Khalil, M.T. 1980. [Comparative studies on the growth of *Pinus brutia* in pure and mixed plantations.] Mesopotamia Journal of Agriculture. 15(1): 61–73. [Original in Arabic].
17. Haseeb, A.; Khan, A.M.; Saxena, S.K. 1981. Some new host records of the root-knot nematode, *Meloidogyne javanica* (Treub) Chitwood. Current Science. 50(24): 1,079.
18. Holdridge, L.R. 1967. Life zone ecology. San José, Costa Rica: Tropical Science Center. 206 p.
19. Hughes, C.E.; Styles, B.T. 1984. Exploration and seed collection of multi-purpose dry zone trees in Central America. International Tree Crops Journal. 3: 1–31.
20. Irvine, F.R. 1961. Woody plants of Ghana. London: Oxford University Press. 861 p.
21. Johnson, C.R.; Michelini, S. 1975. Effect of mycorrhizae on container grown *Acacia*. Proceedings, Florida State Horticultural Society. [place of publication unknown]: 87: 520–522.
22. Joshi, H.B. 1983. The Silviculture of Indian trees, rev. ed. Delhi: Government of India Press. 344 p. Vol. 4.
23. Kumar, P.; Purkayastha, B.K. 1972. Note on germination of the seeds of lac hosts. Indian Journal of Agricultural Sciences. 42(5): 430–431.
24. Lauridsen, E.B.; Stubsgaard, F. 1987. Longevity of hardcoated seed after scarification. Technical Note No. 32. Humlebaek, Denmark: Danida Forest Seed Centre. 3 p.
25. Lawrence, B.M. 1984. Progress in essential oils. Perfumer & Flavorist. 9(3): 35, 45.
26. Liogier, A.H. 1982. Flora of Puerto Rico and adjacent islands: a systematic synopsis. Río Piedras, PR: Editorial de la Universidad de Puerto Rico. 342 p.
27. Little, E.L.; Wadsworth, F.H. 1964. Common trees of Puerto Rico and the Virgin Islands. Agric. Handb. 249. Washington, DC: U.S. Department of Agriculture. 548 p.
28. Marrero, J. 1949. Tree seed data from Puerto Rico. Caribbean Forester. 10: 11–30.
29. Mattis, G. Ya.; Petrov, V.I. 1987. Forestry improvement of arid pastures in India. Lesnoe Khozyaistvo. 8: 47–49.
30. Meyer, R.E.; Bovey, R.W. 1982. Establishment of honey mesquite and huisache on a native pasture. Journal of Range Management. 35(5): 548–550.
31. Mital, V.P.; Khanna, S.S. 1967. A note on tamarind bruchid *(Caryedon gonagra* Fabricus) (Bruchidae, Coleoptera), a serious pest of stored tamarind *(Tamarindus indica* L.) and other leguminous seeds of economic importance. Agra [India] University Journal of Research. 16(2): 99–101.
32. Parrotta, J.A. 1989. *Dalbergia sissoo* Roxb. [Silvics of forest trees of the American tropics]. SO-ITF-SM-24. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 5 p.
33. Parrotta, J.A. 1991. *Pithecellobium dulce* (Roxb.) Benth. [Silvics of forest trees of the American tropics]. SO-ITF-SM-40. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 5 p.
34. Pennington, T.D.; Sarukhan, J. 1968. Arboles tropicales de Mexico. Mexico City, Mexico: Instituto Nacional de Investigaciones Forestales. 413 p.
35. Rasmussen, G.A.; Scifres, C.J.; Drawe, D.L. 1983. Huisache growth, browse quality, and use following burning. Journal of Range Management. 36(3): 337–342.
36. Rice, M.E. 1989. Branch girdling and oviposition biology of *Oncideres pustulatus* (Coleoptera: Cerambycidae) on *Acacia farnesiana*. Annals of the Entomological Society of America. 82(2): 181–186.
37. Ross, J.H. 1975. The typification of *Mimosa farnesiana* [the basionym of *Acacia farnesiana* (L.) Willd.]. Bothalia. 11(4): 471–472.
38. Rzendowski, J. 1981. Vegetación de México. Mexico City, Mexico: Editorial Limusa. 432 p.
39. Scifres, C.J. 1974. Salient aspects of huisache seed germination. Southwestern Naturalist. 18(4): 383–392.
40. Sebastian, M.K.; Bhandari, M.M. 1984. Medico-ethno botany of Mount Abu, Rajasthan, India. Journal of Ethnopharmacology. 12: 223–230.
41. Secor, J.B.; Conn, E.E.; Dunn, J.E.; Seigler, D.S. 1976. Detection and identification of cyanogenic glucosides in six species of *Acacia*. Phytochemistry. 15(11): 1,703–1,706.
42. Seigler, D.S.; Conn, E.E.; Dunn, J.E.; Janzen, D.H. 1979. Cyanogenesis in *Acacia farnesiana*. Phytochemistry. 18: 1,389–1,390.
43. Seigler, D.S.; Seilheimer, S.; Keesy, J.; Huang, H.F. 1986. Tannins from four common *Acacia* species of Texas and northeastern Mexico. Economic Botany. 40(2): 220–232.
44. Spaulding, P. 1961. Foreign diseases of forest trees of the world. Agric. Handb. 197. Washington, DC: U.S. Department of Agriculture. 361 p.
45. Srinivasan, P.S.; Vinaya Rai, R.S.; Jambulingam, R. 1989. Acacias: variation between species in early growth and a few drought-adaptive attributes. Journal of Tropical Forest Science. 2(2): 129–134.
46. Standley, P.C. 1922. Contributions from the National Herbarium. Trees and shrubs of Mexico. Washington, DC: Smithsonian Institution. 1,721 p. Vol. 23.

47. Traveset, A. 1990. Bruchid egg mortality on *Acacia farnesiana* caused by ants and abiotic factors. Ecological Entomology. 15(4): 463–467.
48. Traveset, A. 1990. *Ctenoaura similis* Gray (Iguanidae) as a seed disperser in a Central American deciduous forest. American Midland Naturalist. 123(2): 402–404.
49. Troup, R.S. 1921. The silviculture of Indian trees. Oxford, England: Clarendon Press. 1,195 p. 3 vol.
50. U.S. Department of Agriculture. 1960. Index of plant diseases in the United States. Agric. Handb. 165. Washington, DC: U.S. Department of Agriculture. 531 p.
51. Uphof, J.C.T. 1968. Dictionary of economic plants. New York: Verlag von J. Cramer. 591 p.
52. Webb, D.B.; Wood, P.J.; Smith J. 1980. A guide to species selection for tropical and subtropical plantations. Tropical Forestry Paper 15. Oxford, England: Commonwealth Forestry Institute, Department of Forestry, University of Oxford; London: Overseas Development Administration. 256 p.